Advancing Climate Strategies in Rapidly Motorising Countries

PREVIEW

Transport Volume of the Compendium on Baselines and Monitoring

– A comprehensive guide through existing methodologies for GHG quantification of different types of transport mitigation actions

Authors: Chuck Kooshian (CCAP), Steve Winkelman (CCAP), Urda Eichhorst (GIZ), Daniel Bongardt (GIZ)

- DRAFT for Comments -

November 2016

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

CCAP CENTER FOR CLEAN AIR POLICY

Introduction

The Parties to the United Nations Framework Convention for Climate Change (UNFCCC) agreed upon a new climate agreement in Paris in December 2015. Greenhouse gas (GHG) mitigation objectives are set out as nationally determined contributions (NDC). Mitigation actions are the mechanisms to deliver these commitments.

Transport related emissions are growing worldwide especially in developing countries and emerging economies. The development of effective transport climate strategies rests upon the availability of comprehensive data and the application of sound assessment methods for emission reduction potentials. Unfortunately, many countries lack comprehensive transport emission inventories and mitigation scenario analysis to inform sound climate action planning. One effort to build capacity in this area is the development of a Compendium on GHG Baselines and Monitoring.

The Compendium

The Compendium on GHG Baselines and Monitoring is a UNFCCC coordinated, multi-stakeholder effort to provide a resource map of methodologies, methods and tools for establishing baselines and monitoring emissions reductions from mitigation actions. The Compendium covers methodologies in all IPCC sectors, systematized into three tiers according to their level of complexity, comprehensiveness and data-and-expertise intensity of use. It will ultimately include a web-portal that contains links to the methods, models, methodologies and tools described in the Compendium, and a series of webinars and trainings to disseminate collected knowledge to key stakeholders.

This Volume on transport (Volume 6) is coordinated by GIZ in cooperation with SLoCaT with funding from the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and written with the assistance of the Center for Clean Air Policy (CCAP). It contains a brief description of each of a number of different types of transport sector mitigation actions, a list of existing methodologies applicable to the actions with references to existing documentation if available and a discussion of advantages, disadvantages and limitations of different methodologies.

Early drafts of each volume will go through expert review. Final drafts of each chapter are expected to be ready for final review by April, 2017. After that, cross chapter review will take place to coordinate the entire document.

This Volume is complemented by a database and overview of methodologies and tools prepared by SLoCaT. This database provides even more methodologies or tools and allows analysis based on different criteria, while the Transport Volume provides more detail and guidance on the applicability and characteristics of major methodologies for different types of mitigation actions. The Transport Volume helps readers find appropriate methodologies for the mitigation action they are considering.

This paper is a preview of what will be included in the initial release of the Volume. It includes:

1. A reader guide to the mitigation action sections to explain how the methodologies will be presented;
2. An overview of all the methodologies that will be covered
3. A draft of the first mitigation action type

The preview is also a call for additional methodologies. **If you know of a methodology that might be included in the compendium please contact: Urda Eichhorst (urda.eichhorst@giz.de)**

Reader guide to the mitigation action sections of the Volume

Each mitigation action type follows the same structure:

x. Mitigation action type – *Name of the action type*

Mitigation actions are grouped into types that have similar profiles in terms of mechanisms, scope and indicator variables.

x.1. Description and characteristics of action type – *shows what the section is addressing*

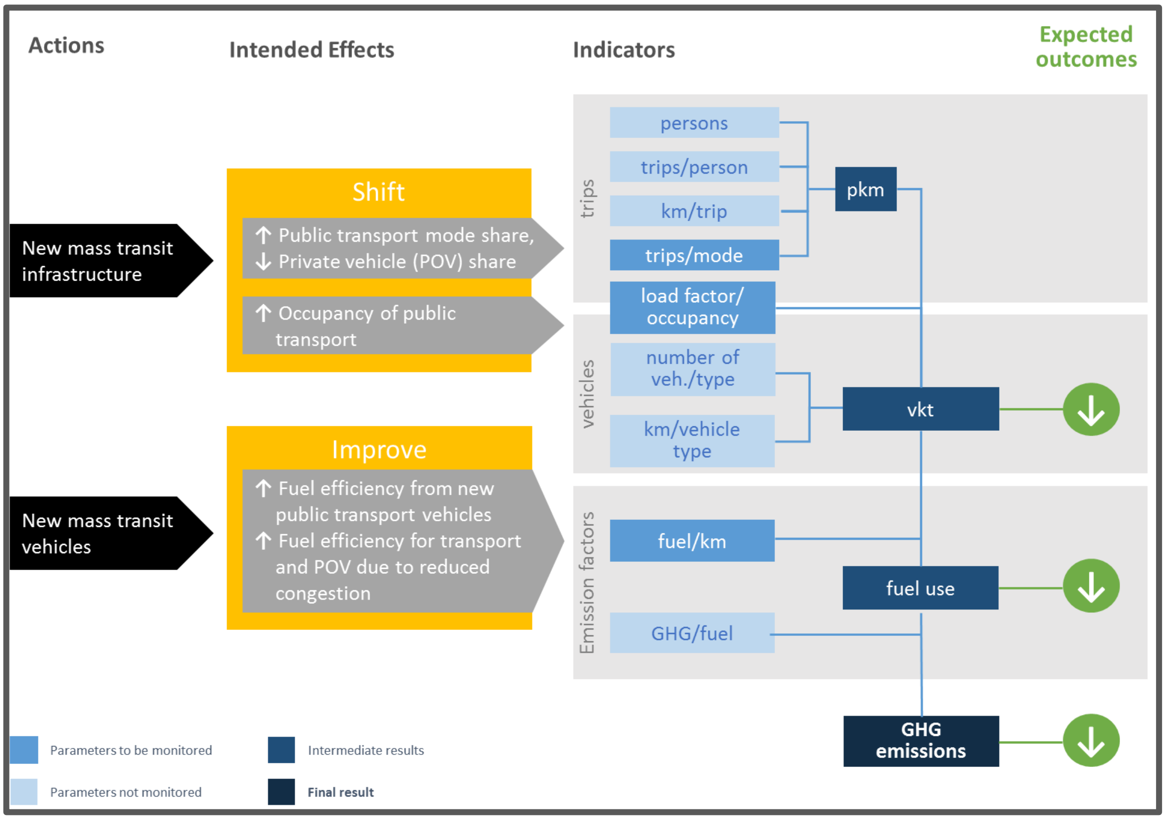
First, the mitigation action type is briefly described in terms of four key characteristics: its focus within the ASIF framework, the type of instrument, the scale and the affected modes.

Then the expected outcomes of successful implementation are described. The description includes the general mechanisms through which the mitigation actions reduce GHG emissions and some of the co-benefits that could be expected.

x.2. Structure of mitigation effects – *helps the reader understand the logic of the mitigation action so that the analysis methods and tools can be considered more easily*

Cause-impact chain graphic

This section shows the possible specific activities within the mitigation action that are intended to cause GHG emissions to decrease. Each activity is linked to the directional effects it should have on one or more indicators within the transportation emissions causal chain which leads to changes in the intermediate variables and the final result of lower GHG emissions. The graphic essentially summarises the basic approach of each mitigation action type and the monitoring requirements that go with it.



Certain indicators are coloured to show that they are to be monitored for the magnitude of change caused by the actions. The remaining variables are in a different colour to show that the actions are not expected to affect them, and therefore it is permissible to use default values in calculating the impacts.

Key variables to be monitored

The key variables that could change due to the mitigation action are shown in list form, followed by a brief explanation of the expected mechanism that causes them to change. This list includes variables that need to be monitored for either intended or unintended effects (e.g. rebound). It is of course possible, that a specific project may not affect every variable. The variables are highly depending on the specific characteristics of the mitigation action and the related mechanism of change.

Factors affecting change magnitude in key variables

This section describes the contextual factors that cause a stronger or weaker GHG reduction from the same actions.

Boundary setting

This section describes the options within the various parameters that are typically used when setting the boundaries of the analysis for the mitigation action being discussed.

Key methodological issues

Each mitigation action type has different methodological issues based on the causal mechanism and data availability of key variables. These issues are described in this section.

Other policies or actions with potential for double counting

Other policies and actions taken to mitigate GHG outside the analysis boundaries may have synergistic or interaction effects that lead to difficulty in attributing the reduction to any particular action or to counting the same tons more than once for different actions. This section lists the most important issues.

x.3 Determining the baseline and calculating emission reductions – *Outlines the range of options for the analysis approach before the specific tools are presented.*

Analysis approach

There are often multiple options for determining the baseline and with-project scenarios which are needed for analysing the effects of a selected mitigation action type. Some mitigation action types will require a specific analysis approach while others may be more flexible. Ex-ante and ex-post analysis usually have different needs for projections and forecasts versus collection of existing data.

Uncertainties and sensitivity analysis

This section gives an overview of which variables are least certain and level of sensitivity the final results may show to that uncertainty.

x.4. Guidance on the selection of analysis tools for the mitigation action type – *This section is the heart of the chapter. It helps the user to understand a range of existing methodology documents and computer based tools that can be used for analysing the mitigation action type.*

Depending upon the mitigation action type, certain key variables may need to be highly disaggregated to achieve good accuracy in estimation while others may not. The next table lists the variables specific to the mitigation action type by level of accuracy. This table is used in conjunction with the navigation map below and tool descriptions to help choose an appropriate tool.

	Degree of local data disaggregation		
	Lower accuracy	**Medium accuracy**	**Higher accuracy**
Travel activity data	Aggregated variables	Partially disaggregated variables	Highly disaggregated variables
Emission factors	Aggregated variables	Partially disaggregated variables	Highly disaggregated variables

Table: Level of disaggregation of key variables

The navigation map is a graphic representation of the range of tools that are currently available for analysing the mitigation action type. The names of specific software tools, CDM methodology documents and other works that address GHG reduction analysis for the mitigation action type is superimposed upon the map of analysis purposes and accuracy levels. The navigation map provides readers with a basic guide for finding which methodologies and tools may fit their needs.

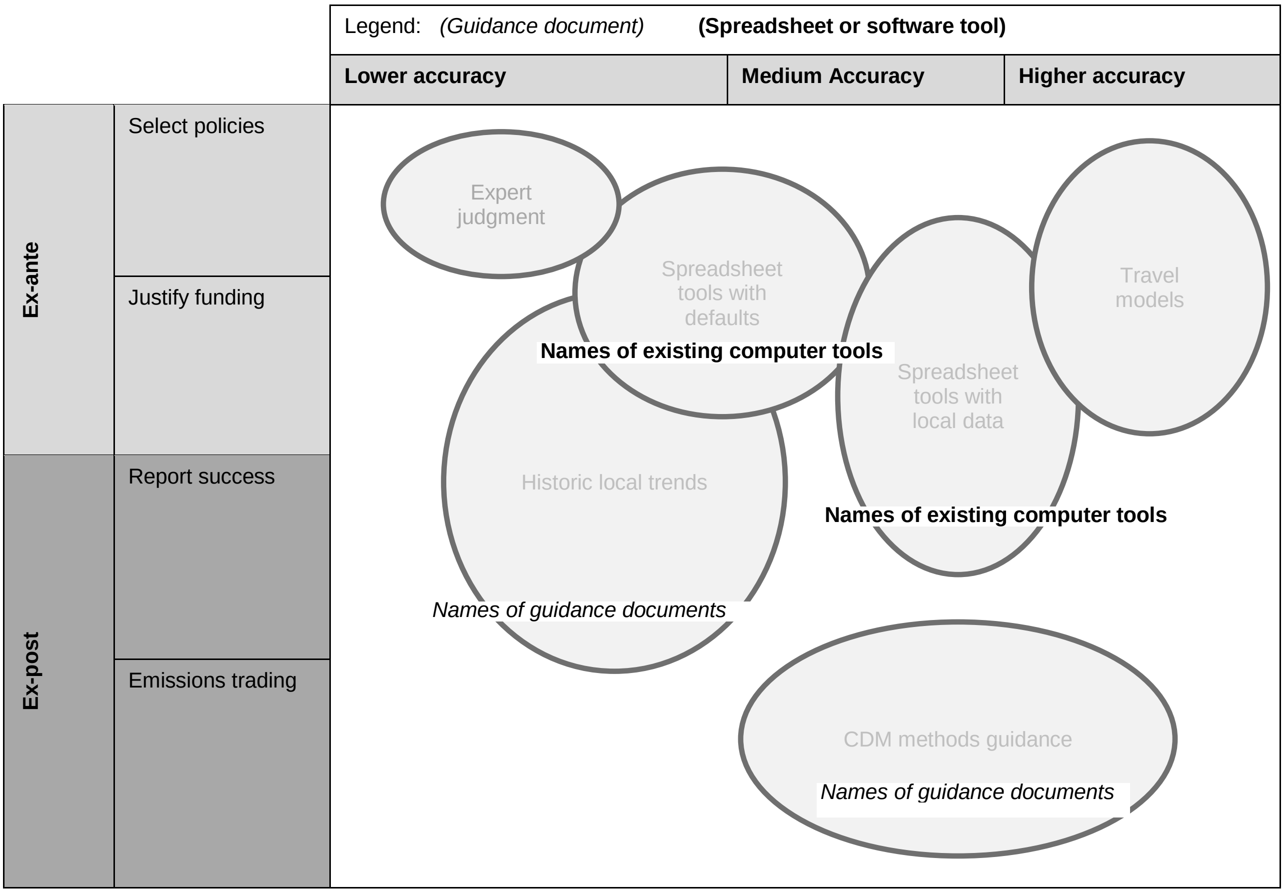


Figure: Navigating classes of available methods and associated tools

The last part of the navigation section presents a description of each tool shown in the map with further details to help the user decide which one is most appropriate for their need.

Class of tool

For strategies with a wide range of tools a number of general categories are suggested following the methodological approaches model and the navigation map. The tool or methodology is put into one or more categories depending on its characteristics.

Ease of use/data collection – provides a qualitative estimation of the level of effort and technical capacity required to use the methodology.

Name	Application /summary	Scope	Computer based	Methodology documentation	Data collection guidance	Defaults Provided	Cost
Includes link or reference	Specific applicability within the general mitigation action type	Level of accuracy, range of actions/ effects analysed	Yes or no	Fair, good, very good, excellent	Is there guidance on collecting data, and for what data	What default variables are provided	High, med, low, free

x.5. Monitoring, reporting and verification – *Basic recommendations for using the indicators to develop an MRV system for the mitigation action are presented here.*

A tiered method of monitoring is suggested using Implementation, Performance and Impact level variables. The table below presents a minimum list of key variables and recommended intervals for measurement if no other requirements are present, (e.g. CDM).

Category	Indicator	Normal monitoring frequency
Implementation indicator	Key actions taken	Upon implementation
Performance indicators	Change in key monitored indicators	Interval between data collection
Impact indicators	Levels of intermediate variables	Interval between data collection
	Final GHG results	Required reporting period

Minimum indicator set for mitigation action type

x.6. Example – *A reference to a documented analysis of a mitigation action*

A brief description and a link to further materials for a case study of an analysis of a mitigation action within the mitigation action type that is ongoing or has been completed.

List of methodologies (to be examined in the Transport Volume and how they are organized by mitigation type)

The methodologies presented in the initial Transport Volume were chosen with a view to cover a broad range of different mitigation action types in terms of scale, type of intervention and affected modes. In addition, focus was put on interventions with significant mitigation potential. The selection was based on SLoCaT's review of transport methodologies and tools (http://www.ppmc-transport.org/ghg-evaluation-methodologies-assessment/) and categorised by type of mitigation action.

Key to description: [scale, instrument type, ASIF lever, mode]

Scales	Instruments	ASIF levers	Modes
▪ Project level ▪ Intermediate level /sub-sector ▪ National / sector level	▪ Regulatory ▪ Investment ▪ Economic (dis-) incentives or fiscal ▪ Planning ▪ Information & communication	▪ Travel activity ▪ Mode shift ▪ Energy intensity ▪ Fuel type	▪ Private vehicle ▪ Public transit/ bus/ trolley/etc. ▪ Non-motorized ▪ Passenger/freight ▪ Road/rail/water

Mitigation action type 1: Intra-urban mass rapid transit investments

[Project or intermediate, investments, mode shift, passenger bus or rail]

Tools and methodologies available:

- ACM0016: Mass Rapid Transit Projects
- AM0031: Bus rapid transit projects
- AMS-III.U.: Cable Cars for Mass Rapid Transit System (MRTS)
- CDM Methodological Tool 18 - Baseline emissions for modal shift measures in urban passenger transport
- BRT-TEEMP
- Metro-TEEMP
- Emission Reduction Volume Calculator for Bus Rapid Transit (BRT) Project
- Modeshift from BRT
- WRI GHG Protocol Policy and Action Standard: Transport sector guidance

Mitigation action type 2: Comprehensive urban transport programmes

[Intermediate, planning/investment/economic, activity/ mode shift, all ground modes incl. NMT)

Tools and methodologies available:

- EERPAT - Energy and Emissions Reduction Policy Analysis Tool
- MRV Blueprint - Sustainable Urban Transport Programmes
- Grütter methodology: trip-based urban transport MRV methodology applied in Costa Rica
- The Tool for the Rapid Assessment of Urban Mobility in Cities with Data Scarcity (TRAM)
- TEEMP-City

In addition several tools exist for ex-ante estimation of emission reduction potentials for project level activities that may comprise part of a comprehensive programme:

- TOD Colombia - see RefDoc Section 4.4 -
- Bikesharing-TEEMP
- Bikeways-TEEMP
- TDM-TEEMP

- Walkability-TEEMP

Mitigation action type 3: Vehicle efficiency improvement programmes

[Sub-sector, economic/regulatory, intensity/fuels, road transit and freight modes]

Tools and methodologies available:

- AMS-III.S.: Introduction of low-emission vehicles/technologies to commercial vehicle fleets
- AMS-III.AP.: Transport energy efficiency activities using post-fit idling stop device
- AMS-III.AA.: Transportation energy efficiency activities using retrofit technologies
- AMS-III.AT.: Transportation energy efficiency activities installing digital tachograph systems to commercial freight transport fleets
- AMS-III.BC.: Emission reductions through improved efficiency of vehicle fleets
- TEEMP-Vehicle Replacement
- MRV-Blueprint: Low rolling resistance tyre labelling and phase out schemes
- MRV-Blueprint Road Freight Transport NAMA in Mexico

Mitigation action type 4: Alternative fuels incentives

[Sub-sector, economic, fuels, road transport modes]

Tools and methodologies available:

- AMS-III.T.: Plant oil production and use for transport applications
- AMS-III.AK.: Biodiesel production and use for transport applications
- AMS-III.AQ.: Introduction of Bio-CNG in transportation applications
- AMS-III.C.: Emission reductions by electric and hybrid vehicles
- UNDP E-BRT – Sri Lanka: NAMA on eBRT Systems of Colombo
- AMS-III.AY.: Introduction of LNG buses to existing and new bus routes

Mitigation action type 5: Inter-urban rail infrastructure

[National, investments, mode shift passenger/freight, rail]

Tools and methodologies available:

- MRV Blueprint based on India Railways NAMA
- Railways-TEEMP
- Railway Freight Electrification-JICA-Climate Finance Impact Tool
- Railway Freight Mode shift-JICA-Climate Finance Impact
- Railway Passenger Mode Shift-JICA-Climate Finance Impact Tool
- AM0090: Modal shift in transportation of cargo from road transportation to water or rail transportation

Mitigation action type 6: Freight transport infrastructure investments to shift mode

[Sector or sub-sector, investments, mode shift, freight rail/water]

Examples of tools and methodologies available:

- RefDoc Section 4.1 - Switching Freight to Short Sea Shipping (Brazil)
- Railway Freight Mode shift-JICA-Climate Finance Impact
- AM0090: Modal shift in transportation of cargo from road transportation to water or rail transportation
- CDM Methodological Tool 17 - Baseline emissions for modal shift measures in inter-urban cargo transport

Mitigation action type 7: National fuel economy standard

[National, regulation, intensity, passenger and/or freight]

Tools and methodologies available:

- New methodology under development by the ICCT on behalf of GIZ

Mitigation action type 8: Pricing policies

[National or local, regulation/fiscal, activity, mode, intensity, road transport]

Tools and methodologies available:

- ICAT methodology on taxation (upcoming)

If you would like to suggest any (a) additional mitigation action type or (b) methodology to be included in the Transport Volume, please get in touch with us!

Contact: urda.eichhorst@giz.de

Example of methodology presentation for different mitigation action types (draft)

1. Mitigation action type 1: Mass transit investments

1.1. Description and characteristics of mass transit investments

This mitigation action covers project level investments that create or extend specific mass transit passenger transport infrastructure in a region. This includes bus rapid transit (BRT), tram, metro, cable cars etc. These actions expand the capacity, frequency, speed and/or coverage of public transport with the goal to increase its mode share while decreasing the mode share of less efficient modes, especially private vehicles. Secondary goals are to increase the per vehicle occupancy of public transport and to improve traffic flow.

The outcomes of successful implementation of this mitigation action will be increasing the mode share of public transport to reduce the VKT of private vehicles, and increasing the efficiency of public transport, leading to reduced GHG emissions through lower overall VKT and transport energy use in the region. Mass transit investments are known to generate a number of sustainable development co-benefits, which may include access to affordable mobility, shorter travel times and reduced accidents. It can also encourage more compact urban developments with increased non-motorized travel, reduced auto ownership and improved health outcomes due to more opportunities to exercise and lower pollution levels.

1.2. Structure of mitigation effects

Cause-impact chain

Mass transit investment actions should result in measurable effects that are reflected in certain indicators in bottom-up models (ASIF approach). The expected changes in those variables will cause the desired outcomes. See Figure 1.

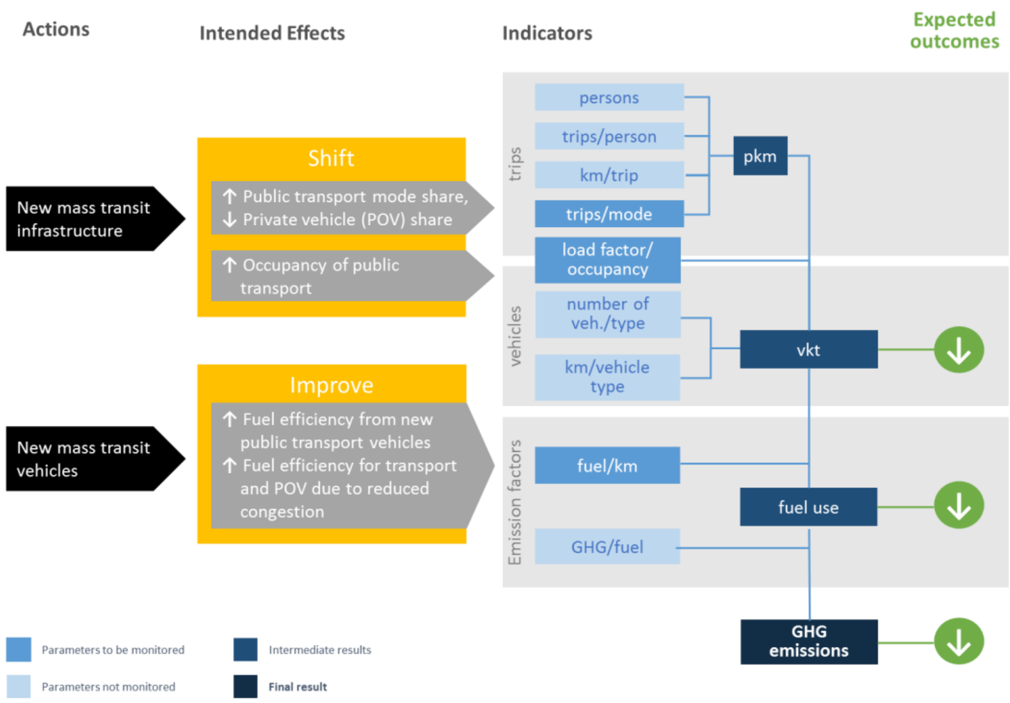


Figure 1: Causal Chain

Key variables to be monitored

The key variables that are expected to change by mass transit investment are listed below, followed by the expected mechanism that causes them to change. A given project may not affect every variable if the appropriate mechanism of change is not present. For example if new transit vehicles are not part of the project, then changes in vehicle occupancy and fuel consumption from new vehicles would not be expected. If no change is expected, then historic or default values can be used.

Monitor for intended effects:

- Mode shares - new, improved transit system will attract travelers from other modes
- Vehicle occupancy of modes – new transit vehicles will have more capacity than old vehicles and will be more utilized
- Fuel efficiency of new vehicles – new transit vehicles will employ more efficient technology and have different fuel consumption and/or different drive technologies
- Traffic speeds – congestion will decrease leading to higher average travel speeds which can affect fuel consumption of all modes

Monitor for unintended effects: [not highlighted by color in figure 1]

- Trips - induced trips can be created by the increased total transport capacity (negative rebound effect)
- Trip length – increased capacity can sometimes lead to longer trip lengths because the induced trips have more distant origins

Factors affecting change magnitude in key variables

The magnitude of change in the key variables will be affected by the specific characteristics of the mass transit investment and also by other contextual factors. To achieve the best effects, the mitigation action must be tailored to the specific context in each city. Some methodologies, travel demand models for example, may be able to quantitatively account for certain contextual factors. For other methods a qualitative assessment using expert judgment may be needed. When performing ex-ante estimation of the mitigation potential of a mass transit action, the following factors can have a substantial impact on magnitude and should be taken into account:

- Quality (travel time, comfort, convenience, etc.) and fare structure of the new public transport lines
- Potential for improved overall travel conditions in corridor (e.g., level of congestion)
- Land use density and diversity in corridor
- Parking availability in corridor
- Pedestrian and bicycle infrastructure
- Transit-supportive land use plans (TOD, parking, pedestrian access)

Boundary setting

New transit lines can draw riders from within walking distance of the corridor, but also via other modes such as bicycle or park and ride from within a larger ride shed. In the longer term, new transit can affect the urban form of an entire city, so the boundary could be as large as the urban area. Boundary will depend the size of the project and on data availability; larger geographical boundaries for analysis can capture more interaction and temporal effects but will require greater data collection costs. Methodologies for urban programmatic actions may become useful if the scope of the project is quite large or includes multiple transit lines. (See Action #XX)

Upstream emissions from electricity generation should be included if the transit system is powered electrically. However if the "additionality" of the project is solely the switch to electric energy, that is if the mass transit line is part of the baseline and the only difference is energy source, then the analysis should consider methodologies under Fuel switching (Action #xx)

Large projects such as new subways may have substantial construction emissions, which should be considered as part of the lifecycle emissions and factored into reduction calculations. In this case it may be necessary to also calculate baseline construction emissions if the BAU scenario includes large roadway or other construction projects.

Dimension	Options for boundary setting
Geographical	Corridor, ride shed, urban area
Temporal	10 – 20 years
Upstream/downstream	Energy sector (electricity, biofuels), may also consider infrastructure construction
Transport sub-sector	Passenger transport, public transit
Emissions gasses	CO_2e (may include CH_4, N_2O)

Table 1: Dimensions of boundary setting

Key methodological issues

The GHG impact depends on the specific characteristics of the transit line, so collection of local variables becomes important. Variables pertaining to the operational characteristics of the old and the new line such as length, current ridership and fuel use of transit vehicles, are usually known or can be obtained without too much difficulty. The main difficulty is in estimating how much the project will attract new riders, change the mode share and reduce private vehicle VKT. A list of specific issues to consider should include:

- Establishing clear causal chain between new transit line and measurable effects
- Estimating mode shares and potential new riders, especially ex-ante.
- Determining if new transit ridership (PKT) will increase transit VKT or increased occupancy will reduce transit VKT
- Data availability on trip length by mode
- Estimating rebound effects – induced trips for public transport and private modes if project increases total capacity
- Availability of disaggregated emissions factors for vehicles types and speeds

Other policies or actions with potential for double counting

Other policies and actions taken to mitigate GHG may have synergistic or interaction effects on a mass transit mitigation action. This can lead to difficulty in attributing the reduction to a particular action or to counting the same tons more than once for different actions. Care should be taken in this regard if any of the following policies or actions is being implemented concurrently with mass transit lines. In some cases a dynamic baseline could account for the effect; in other cases it may be better to analyze the combined effect of the actions rather than trying to disaggregate the reductions. (See Action #xx urban programmatic actions)

Mitigation action	**May affect this variable**
Fuel switching (e.g. subsidies for specific fuel types)	GHG emission factor per unit fuel
Fuel cost (taxes or subsidy removal)	Mode share
Vehicle fuel efficiency improvements (e.g. emission standards)	Fuel efficiency, mode share
Parking pricing	Mode share
TOD policies (promote additional mode shift)	Induced trips, mode share

Table 2: Actions with potential for double counting

1.3 Determining the baseline and calculating emission reductions

Analysis approach

The *baseline scenario* for mass transit investments can be described as "Passengers are transported using a diverse transport system involving buses, trains, cars, non-motorized transport modes, etc. operating under mixed traffic conditions and potentially less efficient vehicles." Baseline emissions are estimated by determining the passenger kilometers traveled (PKT) of each mode, converting them into vehicle kilometers traveled (VKT) by the vehicle type each mode uses and applying an appropriate emission factor.

Current travel data serves as the basis for this baseline calculation, which must then be projected into the future for ex ante analysis and "backcast" for ex-post analysis. Any mass transit investment project should be considered to create a new mode within the study area that alters the distribution and amount of VKT among modes. Ex-ante analysis requires a future projection of this scenario to compare to the baseline scenario.

The most rigorous method for ex-ante analysis, travel demand models, makes future estimates of trips, PKT and VKT for all modes based on spatial interactions. Travel models provide this travel activity input to separate emission factor models to calculate the final GHG impacts. Other methodologies estimate some or all of the travel activity variables using one of the three methods described below, and apply default values for remaining variables. Some older methodologies focus on the projection of passenger trip shares and use defaults for the calculation of PKT and conversion to VKT.[1]

There are three general approaches for projecting or back casting travel activity for baselines or mass transit investment scenarios:

- Travel demand models – generally used for ex-ante analysis of BAU or with project scenarios.
- Expert judgment based on historical trends, using time series data gathered ideally for at least 10 years – can be used for ex-ante projection or ex-post back-casting situations
- Travel activity survey – ex-post is usually done with MRT project passengers, comparing alternative modes to the real situation of using the MRT. Ex-ante can do a stated preference survey to estimate future ridership.

Ex-post analysis also requires estimates of current emissions, which are calculated based on the current transit ridership and traffic counts and respective emission factors within the defined boundaries. Most methodologies focus on the new riders of the mass transit project. Emission reductions, as always, are the difference between the project emissions (real or estimated ex-ante) and the baseline. Consideration of upstream or downstream emissions may vary between methodologies. These emissions can be a factor if the new transit project uses different fuels or substantially greater fuel than the baseline.

Uncertainties and sensitivity analysis

The most uncertain variable in the emission reduction analysis of a mass transit system is usually the ex-ante estimate of mode split and new ridership. Because it depends on the relative attractiveness of the mass transit system versus the previously available modes for each individual rider, it can be hard to estimate unless travel demand models are used. Even then there can be a range of error.

Survey methods can introduce uncertainty as they ask users to state future preference or imagine a counterfactual scenario. Historical methods assume that no critical changes will be introduced. Travel models require projections of future growth as inputs to the model, which is a source of uncertainty for that methodology.

The potential for rebound effects such as induced trips or changes in trip lengths in some modes introduces another uncertainty, especially if there is no analysis of the effect.

1.4. Guidance on the selection of analysis tools for mass transit investments

Higher degrees of accuracy can be obtained with more disaggregated data, if some or all of the data is locally derived. While combining local data with defaults can yield benefits, using disaggregated default data alone is seldom more accurate than aggregated default data. For example, highly disaggregated emissions factors for various types of vehicles at different speeds are available. Using these factors without accurate values for trip length, mode share and fleet composition yields little improvement in accuracy over using average, aggregated factors. The table below shows the disaggregated data that is desirable for each general level of accuracy.

[1] see http://www.apta.com/resources/hottopics/sustainability/Documents/Quantifying-Greenhouse-Gas-Emissions-APTA-Recommended-Practices.pdf

	Degree of local data disaggregation		
	Lower accuracy	**Medium accuracy**	**Higher accuracy**
Travel activity data	• Total vehicle trips • Forecast change in transit ridership • Average occupancy of POV and transit vehicles* • Average trip length*	• Vehicle trips in analysis area by vehicle type • Vehicle trip length by vehicle type • Proposed change in transit VKT from operations (by vehicle type) • Traffic speeds in corridor by vehicle type (and time of day) • Forecast travel speeds by vehicle type after strategy implementation • Forecast change in transit ridership • Trip lengths of new transit trips* • Prior mode shares of new transit riders*	• Person trips in analysis area by vehicle type • Person trip length by vehicle type • Occupancy by vehicle type • Proposed change in transit VKT from operations (by vehicle type) • Traffic speeds in corridor by vehicle type (and time of day) • Forecast travel speeds by vehicle type after strategy implementation • Forecast change in transit ridership • Trip lengths of new transit trips • Prior mode shares of new transit riders • Adjustment for induced traffic due to lower congestion* • Forecast change in private vehicle VKT by vehicle type (modeled)** • All data items by time of day**
Emission factors	• Average emission rates *	• Emission rates by vehicle type • Emission rates by speed* • Emission rates for new transit vehicles (by speed)*	• Emission rates for new transit vehicles (by speed) • Current and future (or improvement factor) emission rates by vehicle type and speed • Rates by emission type* • Construction emission of new transit vehicles and infrastructure**

Table 3: Level of disaggregation of key variables (*=default OK, **= optional item)

Mass transit actions have a long history of in depth analysis, such as ex-ante investment grade demand forecast studies using travel demand models and the detailed methodologies developed for ex-post emissions crediting (e.g. CDM). More recently a number of sketch planning tools have also been developed for rapid assessment of the potential GHG reductions that might be obtained from new transit projects and other similar programs that expand public transport capacity. Figure 2 maps existing methodologies and tools for mass transit investments according to their purpose (y axis) and level of accuracy (x axis).

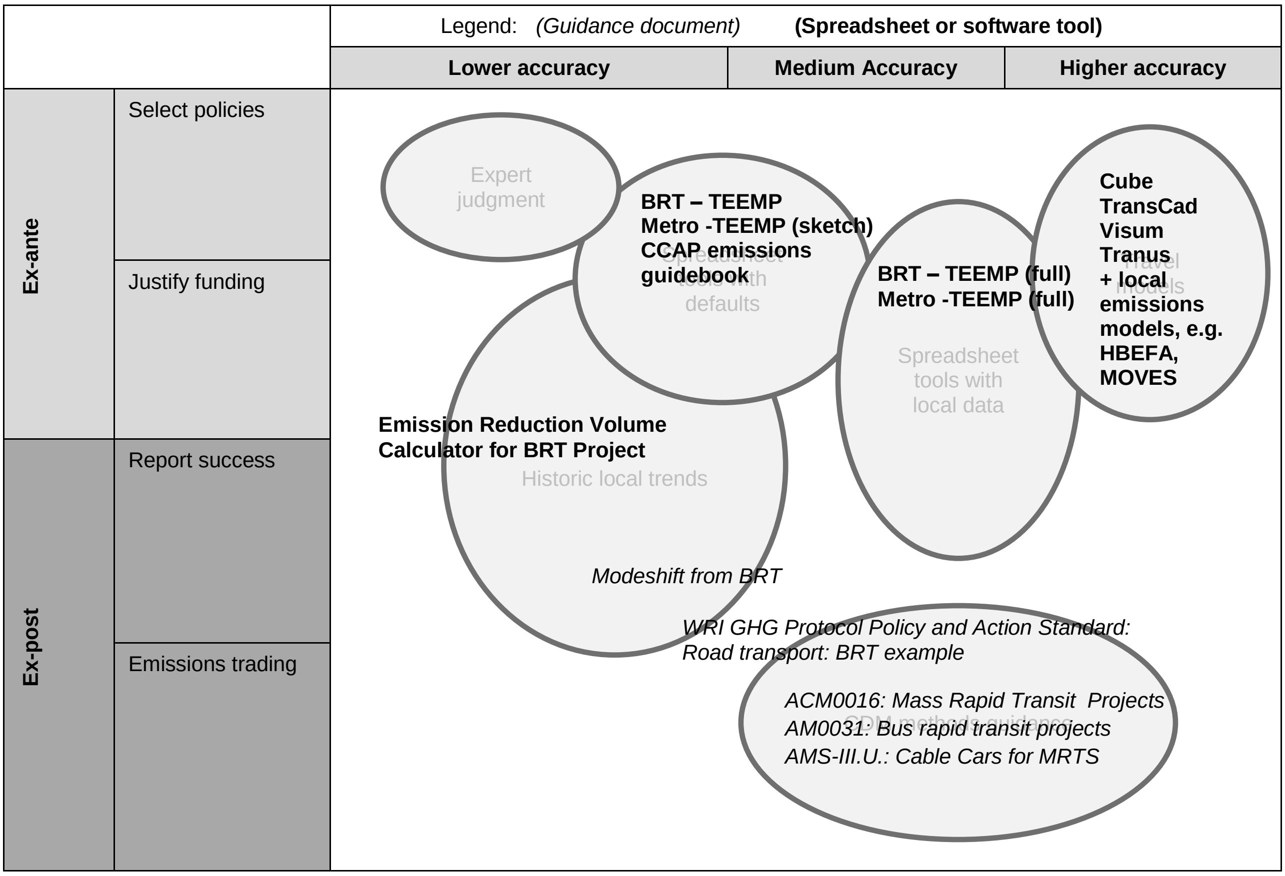


Figure 2: Navigating classes of available methods and associated tools

Travel demand models

These are spatial interaction models that calculate VKT disaggregated by mode, time of day and speed. Trip lengths are based on location of origins and destinations. Mode choice can be modeled based on interaction of origins, destinations and transport systems. Induced trips can be modeled using capacity restraint formula (activity models may have more sophisticated methods). With appropriate sub modules some models can include freight, transit, NMT. Some models can include land use simulations as well. Important disaggregated variables cascade through analysis. Some defaults may be included and models include the ability to change any variable. Models are calibrated by entering local data from detailed travel surveys and comparing the model output to known results. This option is the most accurate choice for forecasting future travel activity parameters.

Typically, highly disaggregated activity data from travel demand models is input to a separate emissions model calibrated to national or supra-national fleets. Some software packages incorporate emissions factors from various sources for an extra cost. External standard emissions models that accept highly disaggregated inputs include MOVES, HBEFA, etc. (Highly disaggregated, e.g. speed sensitive, emission models are discussed under Mitigation Action type 8) Emissions models also have to be adapted to local or at least country-specific circumstances regarding e.g. the underlying fleet composition and emission factors to deliver meaningful results. Travel model outputs can, however, also be aggregated and emissions calculated with simpler emissions factors.

Ease of use/data collection – very difficult

Name	Application /summary	Scope	Computer based	Methodology documentation	Data collection guidance	Defaults Provided	Cost
Cube	Travel activity	Land use module available	yes	excellent	Paid training offered	Internal parameters*	high
TransCad	Travel activity	Emissions module available	yes	excellent	Paid training offered	Internal parameters*	high
VISUM	Travel activity	Emissions module available	yes	excellent	Paid training offered	Internal parameters*	high
EMME	Travel activity	-	yes	excellent	Paid training offered	Internal parameters*	high
Tranus	Travel activity and land use	-	yes	very good	Fair	Internal parameters*	free

Table 4: Travel demand models

*for example friction factors, mode choice curves, and other coefficients for internal sub-models

Disaggregated bottom up ex-post guidance

These are CDM methodology documents or general guidance documents that detail the disaggregated variables that should be collected. The documents often give precise methodologies on how to collect these variables and how to calculate emissions using them, emphasizing the most conservative assumptions. Because CDM is focused on documenting precise amounts of real tons, CDM tools are primarily used ex-post. Ex-ante guidance is only found for CDM additionality testing, which states that future trip length and mode share must be estimated outside of methodology. Sometimes induced trips may be estimated using this methodology. The selected disaggregated variables cascade. Defaults and spreadsheets are not included, although default sources may be referenced.

Ease of use/data collection – difficult

Name	Application /summary	Scope	Compbased	Method. Docum.	Data coll. guidance	Defaults Provided	Cost
ACM0016: Mass Rapid Transit Projects	project activities that establish and operate an MRTS without feeder lines	Ex-post focus; Additionality test; Leakage: bus and taxi occupancy change, congestion effect on fuel efficiency and induced trips, upstream emissions of gaseous fuels	No	excellent	Excellent Includes survey template and guidance	Technology improvement factor Capacity restraint factor IPCC emissions factors	free
AM0031: Bus rapid transit projects	Construction and operation of a new BRT or replace-ment or expan-sions of existing BRT (adding new routes and lines)	Ex-post focus; Additionality test; Leakage: bus and taxi occupancy change, congestion effect on fuel efficiency and induced trips, upstream emissions of gaseous fuels	No	excellent	Excellent Includes survey template and guidance	Technology improvement factor Capacity restraint factor IPCC emissions factors	free
AMS-III.U.: Cable Cars for MRTS	New cable car passenger transport	Ex-post focus; Leakage: general guidance to consider, occupancy guidance for upstream emissions of electricity	No	excellent	Excellent Includes survey template and guidance	Technology improvement factor IPCC emissions factors	free

Name	Application /summary	Scope	Compbased	Method. Docum.	Data coll. guidance	Defaults Provided	Cost
CDM 18: Baseline emissions for modal shift measures in urban passenger transport	activities in urban passenger transport that implement a measure or a group of measures aimed at a modal shift to urban public transit such as metro, bus rapid transit (BRT), light rail and trams transport.	Ex-post focus; General PKM methodology Leakage: general guidance only	no	excellent	Fair, general guidance on paramet-ers to collect	Technology improvement factor Limited global defaults for vehicle occupancy, fuel efficiency, electricity consumption	free
WRI GHG Protocol Policy and Action Standard: Transport sector guidance 2	Uses BRT as example of how to apply protocol	Ex-ante or ex-post; Guidance on setting boundaries and selecting level of detail, identifying first, second and third order effects	No	very good	Good; guidance on develop-ing monitor-ing plans	IPCC emissions factors	free
Modeshift from BRT	New BRT projects	General PKM methodology; refers to the first three CDM methodologies above	No	good	poor	none	free

Table 5: Disaggregated bottom up ex-post guidance

Partially aggregated bottom up spreadsheet tools with defaults

These are spreadsheet based tools that have opportunity for local data to be used but also include a variety of defaults especially for emissions factors. Some have limited methods for estimating future VKT, mode share or ridership.

Ease of use/data collection – moderate

Name	Application /summary	Scope	Comput-er based	Methodology documentation	Data collection guidance	Defaults Provided	Cost
BRT-TEEMP (full)	New or expanded BRT system	Ex-ante focus; includes BRT mode shift estimation if local data available; includes co-benefits estimation	yes	good	fair	Fuel efficiency Occupancy Trip length Some emission factors Construction factors	free
Metro-TEEMP (local data)	New or expanded Metro system (fixed rail)	Ex-ante city-wide; requires local data on mode shift for best accuracy; includes land use effect factor; includes construc-tion life cycle emissions estimator	yes	good	fair	Fuel efficiency Occupancy Trip length Some emission factors Construction factors	free

Table 6: Partially aggregated bottom up spreadsheet tools with defaults

Simple Bottom up tools with mostly default data

May be spreadsheet or other computer program that accepts limited local data but offers default values for emissions. Usually VKT, ridership or mode shift are determined outside the model and entered by the user.

Ease of use/data collection – moderate to low

Name	Application /summary	Scope	Comput-er based	Methodology documentation	Data collection guidance	Defaults Provided	Cost
BRT-TEEMP (sketch)	New or expanded BRT system	Ex-ante focus; includes BRT mode shift estimation based on defaults; includes co-benefits estimation	yes	good	fair	Fuel efficiency Occupancy Trip length Some emission factors Construction factors	free
Metro-TEEMP (default data)	New or expanded Metro system (fixed rail)	Ex-ante city-wide focus; offers default mode shift choices; includes land use effect factor; includes construction life cycle emissions estimator	yes	good	fair	Fuel efficiency Occupancy Trip length Some emission factors Construction factors	free
CCAP Emissions Guidebook	New or expanded BRT/ Metro system	Ex-ante tool; sketch planning estimates based on combining local data and defaults; Includes fuel cost savings calculator	yes	good	fair	Rules of thumb based on case studies	free

Table 7: Simple Bottom up tools with mostly default data

Historical trends or expert judgment methods

This includes using simple regression curves or economic growth factor models for GHG. This category also includes tools that offer emissions factors but offer no guidance on how to prepare the inputs to those factors.

Ease of use/data collection – low

Name	Application /summary	Scope	Comput-er based	Methodology documentation	Data collection guidance	Defaults Provided	Cost
Emission Reduction Volume Calculator for BRT Project	New or expanded BRT system	Requires user to input all travel data except default emission factors; calculates total emissions and reductions	yes	fair	poor	Bus emission factors	free

Table 8: Historical trends or expert judgment

1.5. Monitoring, reporting and verification

Performance of the mitigation action can be monitored by tracking key variables over time. The monitoring frequency will vary, depending on the monitoring regimen and the budget available for data collection. CDM methodologies generally require annual monitoring. National level biennial update reports (BUR) are submitted every two years to the UNFCCC but may not need the most precise project level data. Key mode share and trip length data can require transport surveys that may not be possible on an annual or biannual basis. Although new methods such as mobile phone tracking can substitute for surveys in some instances, many organizations cannot be assumed to have reliable data for all variables annually. However different variables can be updated at different intervals. Transit ridership data is usually collected regularly so that annual monitoring is possible, even if trip length, etc. are only updated every few years.

It is also suggested that information on implementation and performance be included in the monitoring plan to show progress before the full effects of the action may be apparent. The table below presents a minimum list of key variables and recommended maximum intervals for measurement if no other requirements are present, (e.g. CDM).

Category	Indicator	Normal monitoring frequency
Implementation indicator	Construction and operation of new transit line	one time or by construction phase
Performance indicators	Ridership on new line	annual
	Traffic in corridor	annual
Impact indicators	Calculated passenger transport VKT by mode	4-5 years
	Latest emission rates by mode	4-5 years
	Calculated emissions in study area	5 years

Table 9: Minimum indicator set for Mass transit mitigation action

1.6. Example

To be added; here Colombia Transmilenio CDM project.

https://cdm.unfccc.int/Projects/DB/DNV-CUK1159192623.07/view?cp=1

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Sitz der Gesellschaft
Bonn und Eschborn

Friedrich-Ebert-Allee 36 + 40
53113 Bonn, Deutschland
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Deutschland
T +49 61 96 79-0
F +49 61 96 79-11 15

E info@giz.de
I www.giz.de